The evaluation method of the CDIO syllabus achievements based on the examination scoring point

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ABSTRACT

CDIO syllabus has built a clear, complete, systematic and detailed engineering education goal. The curriculum system's design, implementation, evaluation and improvement and other links can constitute a closed-loop control system, which adjusted by constantly improvement can gradually achieve the engineering education goal of CDIO syllabus. Now the weakest link to implement this process is evaluation, which usually includes more qualitative evaluation, less quantitative evaluation, and weak correlation between the target and evaluation, or less result for curriculum system and courses, and more overall and fuzzy evaluation, or taking teachers or experts as evaluation subjects but not the students. So, in this paper the graduation standards for CDIO syllabus have been formulated, evaluation method for graduation requirement achievements based on scoring points has been proposed, evaluation system for graduation requirement achievement has been constructed, and the whole evaluation for graduation requirement achievement has been explored and practiced in automation specialty, which have achieved excellent results.

KEYWORDS

Evaluation , CDIO syllabus , Achievements , Examination , Standards: 2, 3, 11, 12

1. INTRODUCTION

CDIO syllabus has built a clear, complete, systematic and detailed engineering education goal. The key to achieving this goal is to design curriculum system and course outline, implement course teaching, evaluate curriculum system and teaching effect, and promote curriculum system, course outline and course teaching continuously based on the evaluation results. Thus, design, implementation, evaluation and improvement and other links can constitute a closed-loop control system, which adjusted by constantly improvement can gradually achieve the engineering education goal of CDIO syllabus. Now the weakest link to implement this process is evaluation, which usually includes more qualitative evaluation, less quantitative evaluation, and weak correlation between the target and evaluation, or less result for curriculum system and courses, and more overall and fuzzy evaluation, or taking teachers or experts as evaluation subjects but not the students.

Recent years, in universities from all over the world, a lot of work on curriculum system and teaching effect evaluation has been done based on the ideas of "student centered" and "outcomes-based Education (OBE)", etc. Outcomes-based Education (OBE), which was first proposed by Spady [1] in 1981, has become the mainstream idea of educational reform in the United States Britain Canada and other countries. OBE has also been used as engineering education accreditation standards by American Engineering and Technical Education Accreditation Association (ABET) [2]. Vijayalakshmi M. et al [3] used evaluation criteria and matrix to achieve graduation requirements teaching performance evaluation based on the output. First, curriculum learning objectives for each course related graduate design were developed, which should be accordingly corresponding to graduation requirements. Then evaluation criteria for each teaching implementation phase was designed, based on which evaluation matrix covering all parameters of each teaching phase would be established. Using evaluation matrix, evaluation exams and teachers can calculate the reached proportion of each goal. Murray V. et al [4] attempted to drill undergraduate to do scientific research training and achieved satisfactory results. They verified the superiority of the training method by demonstrating students' engineering solutions or business plan creating technology enterprise. Guo Shiqing et al [5] put forward the achievement oriented curriculum planning model based on the concept of curriculum map. Makinda J. et al [6] proposed analytic procedure of curriculum and training program output matrix. The method was applied to the achievement evaluation of civil engineering major in University of Sabah Malaysia, the effectiveness of which was verified by multi round evaluation of different batches of students. Malaysia Institute of information technology (MIIT) developed a computer evaluation system to correlate and simplify the evaluation process of curriculum and training program output, which would promote continuous quality improvement [7]. In China, Dai Bo [8], Li Zhiyi [9] based on the discuss that reverse design should follow the principles, constructed the reverse design's process and main links, put forward the idea, strategy and key points of reverse design. Their researches focused on several key issues involved in reverse design, for example, how to determine the training objectives, graduation requirements, indicators, how to build the curriculum system, how to prepare teaching syllabus, etc., and showed the examples. Zhou, Wei et al[10] based on the discuss which knowledge and ability should be required by mechanical engineering students, improved the teaching process and assessment methods and put forward graduation requirements evaluation according to the school and social evaluation. Ou Hongxiang et al [12] on the basis of constructing and organizing graduation degree evaluation system, explored the quantitative evaluation of graduation requirements. Taking the safety engineering specialty of Changzhou University as an example, they analyzed the implementation points of achievement evaluation in professional certification process as follows: training objectives and graduation requirements, evaluation organization and personnel establishment, correspondence between curriculum system and graduation requirement, the implementation of the evaluation of greater Chengdu, etc.

The quantitative evaluation based on course examination is supposed as one of the most important evaluation methods. However, there are still some problems in the achievement calculation, as follows:

- The relationship between the achievement calculation and course assessment has not been raveled out. There are still some confusions in concepts and methods.
- The relationship between the achievement calculation of the graduates and courses has not been raveled out. The samples for calculating the two achievements are different. And the improvement effects on curriculum system and courses are different neither.

- The method achievement calculation is not perfect. Only score of course, examination and indicators were calculated, but there is still no achievement calculation method based on all course assessments.

So, in this paper the graduation standards for CDIO syllabus have been formulated, evaluation method for graduation requirement achievements based on scoring points has been proposed, evaluation system for graduation requirement achievement has been constructed, and the whole evaluation for graduation requirement achievement has been explored and practiced in automation specialty.

2. THE GRADUATION STANDARDS FOR CDIO SYLLABUS

CDIO syllabus covers the scientific and technical knowledge, capabilities and qualities, what should a modern engineer have. The outline is divided into four aspects: technical knowledge and reasoning ability, individual ability and occupational attitude, interpersonal skills and teamwork skills; the skills of completing the conception, design, implementation, operation for the system under the environment of enterprise and society. The syllabus consists of three levels of index system, which provides specific requirements for curriculum system and curriculum content design. For a specific professional, whose core is to cultivate the students' ability to solve its complex engineering problems, a complete three-lever indicators system for graduation requirements can be established according to CDIO syllabus. The orientation of our school is to cultivate high-level applied talents and the educational objective of automation major is "Automation system engineer for production line". System is the main object what an automation system engineer for production line should face and serve. The system refers to automation system engineering design, automation product integration, automation engineering project implementation, automation system operation and maintenance, automation products and systems technical services, etc. So, the main complex engineering problems to be solved by production automation system engineers are engineering design, product integration, operation maintenance and technical service. Therefore, automation major takes the required engineering ability to solve the above complex engineering problems as the main line. According to four aspects of CDIO syllabus: personal expertise and engineering ability, engineering environment, personal quality , personal professional ability, 12 standards of graduation requirements and three-level index system are formulated, as described in Table 1. Personal expertise and engineering ability have 5 professional standards, which focus on developing students' professional engineering knowledge and engineering ability what are needed to solve complex engineering problems. Engineering background has 2 standards, including the social and environmental background of the project, which focuses on training students to understand the social requirements of the project, environmental constraints on the project and the impact of the project on the environment. Personal quality and personal professional ability have 5 standards, focusing on cultivating students' general engineering ability quality, which are the universal requirements for all engineering education students. Based on CDIO syllabus, 12 graduation requirements are decomposed; the three-level indicator system is formulated. The three-level indicator system of engineering knowledge for first graduation requirement will be showed in Table 2.

Table 1. Primary indicators of graduation requirements for Automation Major

Type	Graduation Requirements for Automation Major

personal expertise and engineering ability	1.	**Engineering knowledge:** be capable of solving automation system engineering design, product integration, operation maintenance and technical service complex engineering problems, using mathematics, natural science, engineering and automation expertise, and understand the current development status and trend of the automation industry
	2.	**Problem analysis:** be able to identify, refine, define, express, analyze, demonstrate and study automation system engineering design, product integration, operation maintenance and technical service complex engineering problems, using related knowledge, and be capable of obtaining the effective conclusion
	3.	**Design solutions:** synthetically considering the social, healthy, safe, legal, cultural and environmental factors, be able to design the system, components and processes for automation system engineering design, product integration, operation maintenance and technical service complex engineering problems, and can reflect the sense of innovation in the design stage
	4.	**Study:** be able to adopt the scientific method based on the principle to study automation system engineering design, product integration, operation maintenance and technical service complex engineering problems, the study including the design of experiments, analysis and interpretation of data, and obtaining the rational conclusion through comprehensive information
	5.	**Use modern tools:** in the solution of automation system engineering design, product integration, operation and maintenance, technical service of complex engineering problems, be able to design, select and use appropriate technology, resources, modern engineering tools and information technology tools for engineering practice which contains the prediction and simulation of complex engineering problems, and can understand the tools' limitations
engineering environment	6.	**Engineering and society:** in the solution of automation system engineering design, product integration, operation and maintenance, technical service of complex engineering problems, be able to reasonably analyze the problems based on related engineering background knowledge, and can understand and evaluate the influence and responsibility of engineering practice on health, safety, law and cultural issues
	7.	**Environment and sustainable development:** be able to understand and evaluate the influence of engineering practice on the sustainable development of environment and society, in the practice of solving automation system engineering design, product integration, operation and maintenance, technical service of complex engineering problems
personal quality	8.	**Professional norms:** possess humanities and social sciences literacy, possess social responsibility, be able to understand and abide engineering ethics and codes during engineering practice, fulfill their responsibilities, have a healthy physique
Personal professional ability	9.	**Personal and teams:** be able to work in a team and in a multidisciplinary environment, and can understand the respective roles of individuals, team members, and supervisors
	10.	**Communicate:** be able to effectively communicate with the industry peers and the public on complex engineering issues in the field of automation, including writing reports, designing presentations, presenting statements, clearly expressing and responding to instructions, have a certain international perspective and foreign language communication skills, be able to communicate with others in a cross-cultural context
	11.	**Project management:** Understand and master the basic knowledge and methods of engineering project management and economic decision, and can apply the knowledge and methods in the engineering practice under multidisciplinary environment
	12.	**Lifelong learning:** be aware of independent learning and lifelong learning ,and be able to learn and adapt to development

Table 2. The three-level indicator system of engineering knowledge for first graduation requirement

Graduation requirements (1-level index)	**Index point (2-level index)**	**Teaching points (3-level index)**
Engineering knowledge: be capable of solving automation system engineering design, product integration, operation maintenance and technical service	1.1 Master mathematical abstractions, logical reasoning, mathematical calculations and modeling knowledge and capabilities to solve complex engineering problems	① Quantity, figure, space and the abstract of the relations; ② Be capable of deductive and inductive reasoning; ③ Be capable of mathematical calculation and proof; ④ Master mathematical description, modeling and solving ability for the complicated engineering problems.
	1.2 Engineering knowledge and cognitive ability required for automation system engineering development	① Physics system principle cognition, experiment design and operation ability; ② Cognition on chemistry and chemical system principle, experiment design

complex engineering problems, using mathematics, natural science, engineering and automation expertise, and understand the current development status and trend of the automation industry		and operation ability; ③ Cognition on mechanical device principle, structure and manufacturing ; ④ Be capable of reading and designing the engineering drawing; ⑤ Cognition on production process flow and its principle.
	1.3 Automatic control system cognition and system thinking ability	① Establish the systematic thinking mode for systematic understanding, description, analysis of things and their interaction; ② Cognition on feedback control principle; ③ Be capable of expression and analysis system structure diagram (block diagram).
	1.4 Computer application knowledge and calculation thinking ability in automation field;	① Computer principle cognition; ② Computational thinking ability; ③ Computer application system software and hardware knowledge.
	1.5 Electronic system engineering knowledge and cognitive ability required to design, manufacture, maintain and serve the electronic automation products;	① Basic circuit analysis methods and basic theory; ② Ability of reading and understanding analog and digital electronic circuits; ③ Cognition on common electronic components, microcontrollers, SCM, FPGA, various types of interface ; ④ The knowledge of electronic automation product development and comprehensive application.
	1.6 Automate engineering knowledge and cognitive ability to solve automation system engineering design, product integration, operation and maintenance, technical services and other complex engineering problems	① Control the principle of common process equipment; ② Be able to design integrated automatic control system and draw P&ID diagram (pipeline instrument chart); ③ Be familiar with products, categories and functions of automation devices and instruments (including sensors, detection components, instrumentation equipment, DCS, PLC, fieldbus, etc.); ④ Be capable of installation, calibration, verification and cable installation for the automation devices and instruments; ⑤ Be able to debug and operate automation system; ⑥ Understand the engineering knowledge such as process, program requirements, quality supervision and production safety.
	1.7 Understand the development status and trend of automation technology and industry.	① Understand the development of automation technology and industry; ② Understand the trends of automation technology and industry.

3. EVALUATION METHOD FOR GRADUATION REQUIREMENT ACHIEVEMENTS BASED ON SCORING POINTS

(1) The relationship between achievements calculation and course evaluation

The basic data for the achievements evaluation comes from the assessment data of the basic teaching activities, that is, the assessment data of teaching points in course teaching assessment teaching assessment link, that is, the scoring points. The calculation method of achievement evaluation and course examination results are not the same but closely related. Closely relationship is that the two methods are from examine data in teaching points, namely, scoring points, where the different is the way and the goal of calculation, as shown in figure 1. The calculation of course scoring results uses the graduation standard as a whole goal. First, the scoring points of course examine results into examine scores, then to get overall performance. The all process is a examine of graduation standard overall goal, and no clear different of indicator points are calculated, so it leads to one course of one student correspondence to one average scores: allover scores. The calculation of achievement evaluation come from different indicator points, and the examination scoring points come from the different of achievements, so one examination step can results into some indicators of achievements, namely, one course of one student can correspond to more than one average score: different indicator points of achievements.

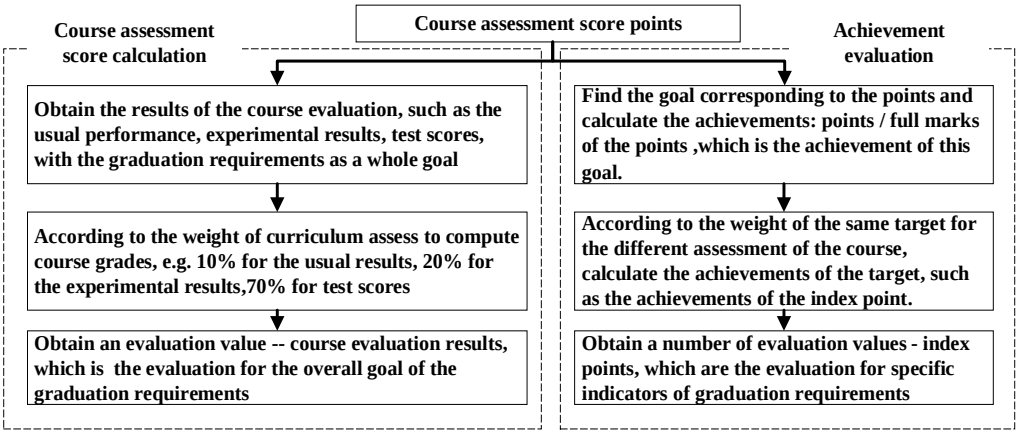

Figure 1. The relationship between achievements calculation and course evaluation

(2) The computing method of the achievements for the graduation requirements

In this paper, we present an evaluation method of graduation requirement achievements based on the examination scoring points. It first calculated the achievements of scoring points, namely, the score divide the full score, then according to the course assessment of different examination step, weighted sum calculation of indicators point results into the achievements. Lastly, weighted accumulative calculation of curriculum system results into the achievements. As shown in figure 2. Special note that the score point should be evaluation of teaching points, and course teaching should be a decomposition of graduation standard indicators, so scoring point calculation is corresponding to the achievements of teaching points, this curriculum teaching process, curriculum design, curriculum system can effectively achieve the graduation requirements.

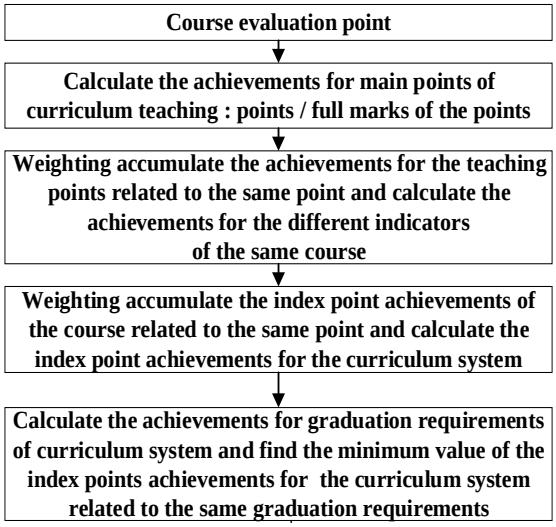

Figure 2. The computing method of the achievements for the graduation requirements

The computing method of the achievements for the graduation requirements is showed as follows:

Step1: Formulate the index system of graduation requirements

12 graduation requirements are decomposed into graduation requirements, index points, three-lever index system for teaching points, which respectively are the teaching objectives of the curriculum system, curriculum and the three-level teaching activities in the teaching link.

Step2: Establish the relationship between teaching objectives and teaching activities, and set a reasonable weight matrix

①Establish the relationship between graduation requirements and curriculum system, and construct correlation matrix with strong correlation, general association and weak association. There are n courses to support the achievements of the i-th graduation requirements.

②Establish the relationship between index points and curriculum system, and construct association matrix as weight. The i-th graduation requirements have m index points. The k-th course supports the achievements of the j-th index point for the i-th graduation requirements (hereafter this text will be abbreviated as "Index Point i,j"), the weight is $W_{i,j,k}$.

③Establish the relationship between index points and course teaching links, and construct association matrix as weight. The p-th teaching link of the k-th course supports the achievements of "Index Point i,j", the weight is $F_{i,j,k,p}$.

④Establish the relationship between teaching points and teaching links, and construct association matrix as weight. The p-th teaching link of the k-th course supports the achievements of the r-th teaching points for "Index Point i,j", the weight is $R_{i,j,r,k,p}$.

Step3: Taking teaching key points as the goal, establish the evaluation standard of teaching link and calculate the achievements of sample students' teaching points

Based on the achievements of teaching points, develop assessment criteria for teaching link assessment, and get the ratio of examination results for teaching points in teaching links obtained by sample students to full marks. The p-th teaching link of the k-th course supports the achievements of the r-th teaching points for "Index Point i,j", whose proportion to full marks is $S_{i,j,r,k,p}$, that is, sample students' teaching achievement.

Step4: Calculate the achievements of index points for sample students' courses, with index points as the goal

Based on the achievements of teaching points in teaching links, calculate the achievements of index points for sample students' courses, according to the relationship between teaching points and teaching links, the relationship between index points and teaching links, and the corresponding weight coefficients.

①Calculate the achievements of index points for teaching and assessment link. The p-th teaching link of the k-th course supports the achievements of the r-th teaching points for "Index Point i,j", whose proportion to full marks is $S_{i,j,r,k,p}$. Weighted add up the proportions which the p-th teaching link of the k-th course supports the achievements of all teaching points for "Index Point i,j", so the achievements of "Index Point i,j" for the p-th teaching link obtained by sample students' is $H_{i,j,k,p}$, the calculation as shown in the form Eqn (1).

$$H_{i.j,k.p} = \sum_{r} \left(R_{i.j.r,k.p} \bullet S_{i.j.r,k.p} \right) \quad (1)$$

②Calculate the achievements of index points for the curriculum. Weighted add up the achievements of all teaching points for "Index Point i,j" for the k-th course, so the achievements of "Index Point i,j" for k-th course obtained by sample students' is $C_{i.j.k}$, the calculation as shown in the form Eqn (2).

$$C_{i.j,k} = \sum_{p} \left(F_{i.j,k.p} \bullet H_{i.j,k,p} \right) \quad (2)$$

Step5: Calculate the achievements of index points for sample students' curriculum system, with index points as the goal

Weighted add up the achievements of "Index Point i,j" for all courses, so the achievements of "Index Point i,j" for curriculum system obtained by sample students' is $I_{i.j}$, the calculation as shown in the form Eqn (3).

$$I_{i,j} = \sum_{k} \left(W_{i.j,k} \bullet C_{i.j.k} \right) \quad (3)$$

Step6: Calculate the achievements of graduation requirements for sample students' curriculum system, with graduation requirements as the goal

Take the minimum in all achievements of index points for i-th graduation requirements as the achievement for i-th graduation requirements, so the achievement of graduation requirements obtained by sample students is A_i, the calculation as shown in the form Eqn (4).

$$A_i = \operatorname{Min}_{j} \left(I_{i,j} \right) \quad (4)$$

4. EVALUATION SYSTEM FOR GRADUATION REQUIREMENT ACHIEVEMENT

To implement the achievement evaluation of graduation requirements, we constructed a standard evaluation system to decompose graduation requirements, design the teaching activities, calculate teaching activities achievements, continuously improve the teaching activities and show an evaluation mechanism of self-evaluation. The evaluation process and system is shown in figure 3. Two objects of achievements are graduates and courses. If the object is a undergraduate, the evaluation results from the teaching activity of training scheme, namely the graduate's curriculum system, course, teaching evaluation of learning outcomes, and the goal is to evaluate achievement of graduation requirements. If the object is a course, the evaluation results from the teaching effect of graduation requirements. And the goal is to evaluate achievement of course teaching.

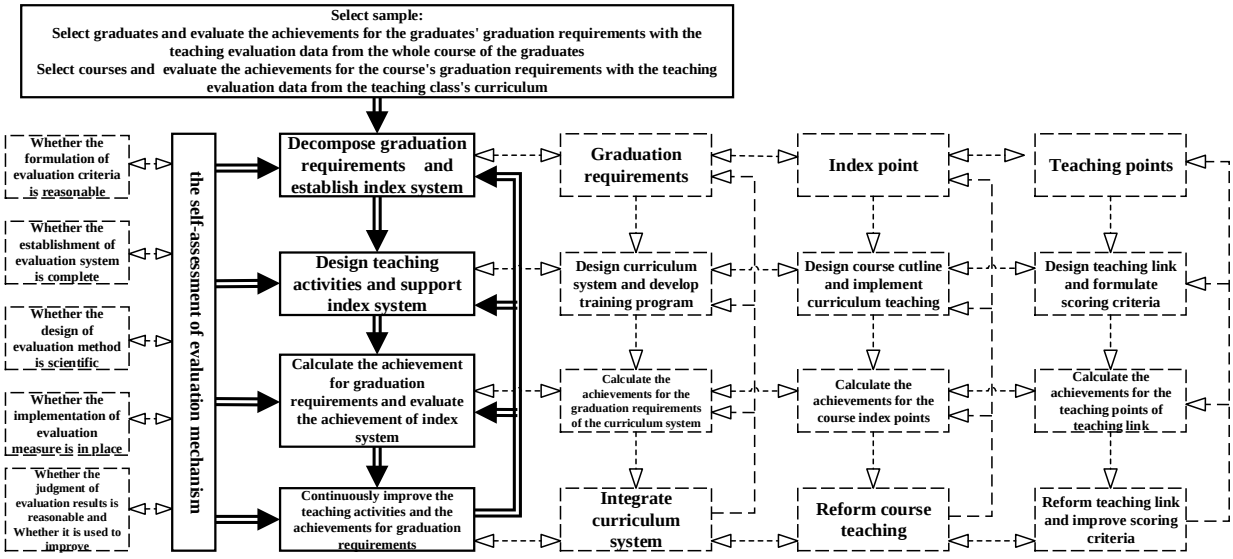

Figure 3. The evaluation system of the achievements for graduation requirements

The graduation requirements of automation major are decomposed into graduation standard, index point, teaching points based on CDIO syllabus, and these indicate the teaching goal of three hierarchical teaching activities including the curriculum system, courses and teaching programs. The design results of these three hierarchical teaching activities are specialty cultivation plan (curriculum system), course outline, teaching program and assessment scoring standard. The achievement evaluation of graduation requirements initiates from the assessment data representing the achievement of key points by means of the teaching program. Then the recurrent calculation takes place. According to the data of calculation process, continuous improvements on curriculum system integration, course teaching reform, teaching program and assessment have been implemented. The self-assessment of evaluation mechanism is to take place based on the judgment of whether or not it is reasonable to form the evaluation standard, whether or not the system establishment is complete, whether or not the method designation is scientific, whether or not the step is done in place, whether or not the results are reasonable, whether or not the standard has been used in continuous improvement, etc.

5. CALCULATION FOR GRADUATION REQUIREMENT ACHIEVEMENT

(1) Reversely design curriculum system with graduation requirements as the goal

The professional graduation requirement is achieved by the reverse design of a reasonable curriculum system, and the curriculum system for graduation requirement is supported by implementing each course. The graduation requirement achievement is realized by the relationship between the curriculum and graduation requirement index points. The graduation requirement is carried out according to the index points, and the relationship between graduation requirement indexes and curriculum is established by matrix. The correlation degree is expressed by weight coefficient Wi.j.k. The strong correlation set the weight coefficient which is greater than 0.5, the general correlation set the weight coefficient which is 0.2--0.4, the weight coefficient is 0.1 set for the weak correlation. The sum of the weight coefficients for all support courses which are corresponding to each graduation requirement index point must be 1.

(2) Design the curriculum syllabus with index points as the goal

We refine course teaching, design course teaching link and establish index point and course teaching link relation. Each course teaching and assessment links should be refined. Course content, teaching method and examination methods should be designed. The curriculum syllabus is carried out according to the graduation requirements index points, and the relationship between graduation requirement indexes and course teaching and assessment link is established by matrix. The correlation degree is expressed by weight coefficient Fi.j,k.p . The strong correlation set the weight coefficient which is greater than 0.5, the general correlation set the weight coefficient which is 0.2--0.4, the weight coefficient is 0.1 set for the weak correlation. The sum of the weight coefficients for all support courses which are corresponding to each graduation requirement index point must be 1. The relationship between graduation requirements index points and curriculum teaching and assessment links for Electronic Engineering Design will be shown in table 3.

Table 3. The relationship between graduation requirements index points and curriculum teaching and assessment links for Electronic Engineering Design

Curriculum		Electronic Engineering Design									
Graduation requirements	Index point	1.5 Electronic system engineering knowledge and cognitive ability for design, manufacture, maintenance and service of electronic automation products	2.2 Analysis ability for function, structure and system of electronic automation products	3.2 Be able to design electronic engineering systems and automation product with the awareness of health, safety, environment	5.1 Be able to make, debug and test the commonly used electronic instruments and electronic automation product	9.1 Correctly understand the relationship between individuals and teams under the multidisciplinary environment, and develop effective teams	9.3 Understand the role of team members and head, be capable of certain team leadership skills	10.2 Be capable of written and graphic communication, oral and personal communication, electronic and multimedia communications with industry peers and the public on complex engineering problems in automation	11.1 Understand and grasp the overall framework of project management and economic decision	11.2 Understand project's time and cost management, quality and risk management, and human resource management, and apply these to multidisciplinary environmental engineering practice	Σ
	Weight coefficient of index points	0.1	0.2	0.3	0.3	0.1	0.1	0.2	0.1	0.1	1.5
Teaching and assessment links		Weight coefficient of teaching and assessment links									Course grade
Pattern	Weight										
Commonly use of electronic equipment and basic experimental operation	0.05				1						1
Hardware and software acceptance	0.6		0.1	0.6	0.2				0.1		1
Defense	0.1				0.4			0.6			1
Exam	0.1	0.1		0.5	0.2		0.1			0.1	1
Report writing	0.1				0.2			0.8			1
Team work assessment	0.05					0.6	0.4				1
weight Σ	1	0.1	0.1	1.1	2	0.6	0.5	1.4	0.1	0.1	
Index point achievement											

(3) Design assess criteria in teaching link with teaching points as the goal

Course teaching link implements teaching based on the relevant teaching points of relevant index points. The realization of teaching points determines the teaching quality of relevant teaching links. So we reasonably design teaching links based on the teaching points of each course's related index points, check the teaching links with the realization of teaching points, formulate the teaching link assessment scoring standards with teaching points achievement as the assessment target. Teaching points score divided by setting out is the teaching points achievement. The assessment scoring standards of examination teaching and teaching links for Electronic Engineering Design will be shown in table 4.

Table 4. The assessment scoring standards of examination teaching and teaching links for Electronic Engineering Design

Teaching and examination			Examination		
Serial Number	Teaching points	weight	Scoring criteria (50 points)	Scoring	teaching points achievement
1	1.5-④ Electronic automation product development and its integrated application knowledge	10%	2 fill-in-the-blanks exercises are set, each question accounts for 2 points, there are altogether 4 points. Assessment for basic theory of electronic circuits, analog electronic and digital electronics, basic concepts of electronic engineering design.		Score / Full mark
2	3.2-① Electronic system structure design	5%	1 fill-in-the-blanks exercises is set, each question accounts for 2 points, there are altogether 2 points. Assessment for composition of temperature measurement control system and the function of each part.		Score / Full mark
3	3.2-② Hardware and software design for analog and digital circuit	45%	2 fill-in-the-blanks exercises are set, each question accounts for 2 points, 2 analytical questions are set, each question accounts for 10 points, there are altogether 20 points, there are altogether 4 points. Assessment for the design, function and composition for regulated power supply module, signal conditioning module, A/D module, D/A module, control module, keyboard and display module.		Score / Full mark
4	5.1-① Selection of electronic components and common use of common instruments	12%	3 fill-in-the-blanks exercises are set, each question accounts for 2 points, there are altogether 6 points. Assessment for use knowledge of resistors, capacitors, inductors and other basic components		Score / Full mark
5	5.1-② Design, fabrication, welding and commissioning for PCB	8%	2 fill-in-the-blanks exercises are set, each question accounts for 2 points, there are altogether 4 points. Assessment for the application of PROTEL software and welding of printed circuit board.		Score / Full mark
6	9.3-① Correctly understand the role and responsibility of team members and head	10%	1 short answer question is set, there is altogether 5 points. Choose one from 6 and 7. Assessment for the understanding for the basic concepts of individuals and teams (such as team definition, team formation and lifecycle).		Score / Full mark
7	9.3-② Clear the team's overall and specific objectives, reasonably make work plan		1 short answer question is set, there is altogether 5 points. Choose one from 6 and 7. Assessment for the understanding for the role of team members and how to better implement the role of rationalization proposals.		
8	11.2-① Project specific activities defined, activity sequencing, time estimating, schedule and time control	10%	1 short answer question is set, there is altogether 5 points. Choose one from 8 and 9. Assessment for how to understand the basic concepts of project management (e.g. scheduling, time control, etc.)		Score / Full mark
9	11.2-② Resource allocation, cost, expense budget and cost control for the project		1 short answer question is set, there is altogether 5 points. Choose one from 8 and 9. Assessment for how to understand the basic concepts of project management (e.g. resource allocation, quality and risk management, etc.)		
General Comment					

(4) Calculate graduation requirements achievement

We should calculate graduation requirements achievement from the teaching link assessment data of all courses of for the graduates. We should hierarchically and gradually calculate graduation requirements achievement, according to the relationship between

teaching links and teaching points, courses and index points, curriculum system and index points, curriculum system and graduation requirements. The calculation steps are shown in figure 4.

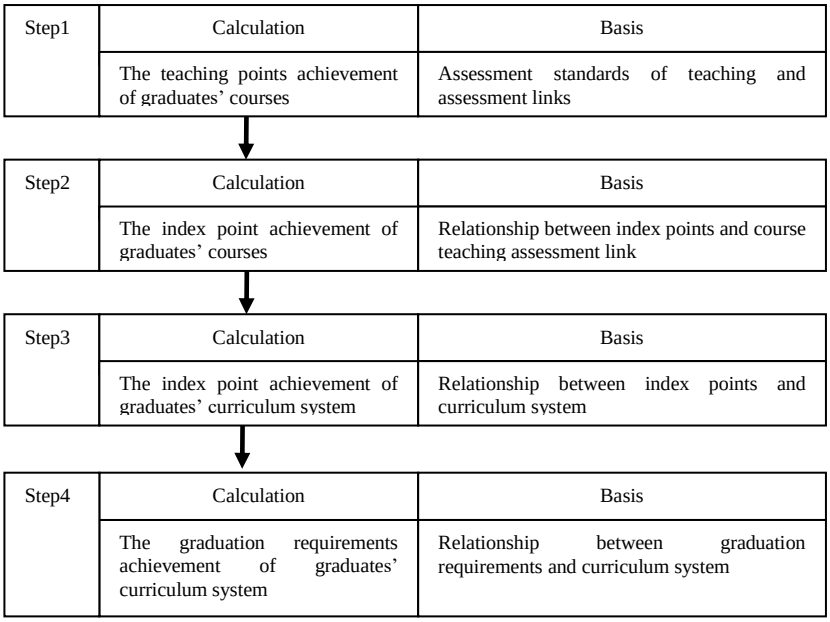

Figure 4. Calculation of graduation requirements achievement for teaching activities

The calculation of the index point achievements for the course is shown in table5.

Table 5. Calculation of the index point achievements for Electronic Engineering Design

Curriculum		Electronic Engineering Design									
Graduation requirements	Index point	1.5 Electronic system engineering knowledge and cognitive ability for design, manufacture, maintenance and service of electronic automation products	2.2 Analysis ability for function, structure and system of electronic automation products	3.2 Be able to design electronic engineering systems and automation product with the awareness of health, safety, environment	5.1 Be able to make, debug and test the commonly used electronic instruments and electronic automation product	9.1 Correctly understand the relationship between individuals and teams under the multidisciplinary environment, and develop effective teams	9.3 Understand the role of team members and head, be capable of certain team leadership skills	10.2 Be capable of written and graphic communication, oral and personal communication, electronic and multimedia communications with industry peers and the public on complex engineering problems in automation	11.1 Understand and grasp the overall framework of project management and economic decision	11.2 Understand project's time and cost management, quality and risk management, and human resource management, and apply these to multidisciplinary environmental engineering practice	Σ
	Weight coefficient of index points	0.1	0.2	0.3	0.3	0.1	0.1	0.2	0.1	0.1	1.5
Teaching and assessment links		The index point achievements of teaching and assessment links / weight coefficient									Course grade
Pattern	Weight										
Commonly use of electronic equipment and basic experimental operation	0.05				0.87 /1						4.31
Hardware	0.6		0.80	0.74	0.86				0.87		51.54

and software acceptance			/0.1	/0.6	/0.2				/0.1		
Defense	0.1				0.76 /0.4			0.83 /0.6			7.69
Exam	0.1	0.83 /0.1		0.58 /0.5	0.80 /0.2		0.75/0. 1			0.77 /0.1	6.93
Report writing	0.1				0.76 /0.2			0.84 /0.8			7.85
Team work assessment	0.05					0.85/0.6	0.91 /0.4				4.35
weight Σ	1	**0.1**	**0.1**	**1.1**	**2**	**0.6**	**0.5**	**1.4**	**0.1**	**0.1**	Class average
Index point achievement		0.83	0.80	0.67	0.83	0.85	0.88	0.84	0.87	0.77	82.66

The index point achievement of each graduate's curriculum system is shown in table 6.

Table 6. Calculation table for the achievement of index point 3.3

Number	Index i.j	3.3 Be capable of configuration, software design and debugging for PLC, DCS, FCS control system		
	Course	Principle and application A of DCS/PLC/FCS	Principle and application B of DCS/PLC/FCS	Index point achievement of curriculum system
	$W_{i.j.k}$	0.5	0.5	
…	…	…	…	…
12	Wang XN	0.56	1.00	0.78
13	Zhang Yu	0.78	1.00	0.89
14	Li GL	0.74	1.00	0.87
15	Liang ZW	0.53	1.00	0.76
16	Zhang RP	0.69	1.00	0.85
17	Hong TZ	0.89	1.00	0.94
18	Wang QS	0.70	1.00	0.85
19	Liu ZY	0.64	1.00	0.82
20	Wang XL	0.84	1.00	0.92
21	Zhang AK	0.64	1.00	0.82
22	Zhang Hao	0.69	1.00	0.84
…	…	…	…	…
2015 session's average		0.71	0.85	0.78

Graduation requirements achievement for each graduate's curriculum system is shown in table 7.

Table 7. Calculation table for the achievement of graduation requirement 3.3

Number	Graduation Requirements	3.Design solutions: synthetically considering the social, healthy, safe, legal, cultural and environmental factors, be able to design the system, components and processes for automation system engineering design, product integration, operation maintenance and technical service complex engineering problems, and can reflect the sense of innovation in the design stage				
	Index i.j	3.1 The ability of designing, programming and debugging computer programming (Achievement)	3.2 Be able to design electronic engineering systems and automation products with the health, safety, environmental awareness.(Achievement)	3.3 Be capable of configuration, software design and debugging for PLC, DCS, FCS control system.(Achievement)	3.4 Be able to design and integrate automatic control system engineering with health, safety and environmental awareness.(Achievement)	The graduation requirements achievement for curriculum system A_i
…	…	…	…	…	…	…
12	Wang XN	0.83	0.76	0.78	0.73	0.73
13	Zhang Yu	0.76	0.80	0.89	0.81	0.76
14	Li GL	0.75	0.84	0.87	0.81	0.75
15	Liang ZW	0.72	0.86	0.76	0.82	0.72
16	Zhang RP	0.83	0.79	0.85	0.75	0.75
17	Hong TZ	0.69	0.94	0.94	0.84	0.69
18	Wang QS	0.71	0.78	0.85	0.78	0.71
19	Liu ZY	0.70	0.78	0.82	0.78	0.70
20	Wang XL	0.91	0.92	0.92	0.86	0.86
21	Zhang AK	0.75	0.79	0.82	0.71	0.71

22	Zhang Hao	0.75	0.84	0.84	0.83	0.75
…	…	…	…	…	…	…
2015 session's average			0.82	0.78	0.78	0.78

(5) Analyze the graduation requirements achievement

The calculation of the most recent (2015) graduates' graduation requirements achievement is shown in table 8.

Table 8. Calculation for the achievement of graduation requirement 2

2.Problem analysis: be able to identify, refine, define, express, analyze, demonstrate and study automation system engineering design, product integration, operation maintenance and technical service complex engineering problems, using related knowledge, and be capable of obtaining the effective conclusion							
Index i.j	Compulsory Course k	weight coefficient $W_{i.j.k}$	Assessment Methods	Achievement's evaluation period	Evaluation result of index point achievement		Evaluation result of graduation requirements achievement
2.1 Be capable of mathematical description, analysis, modeling for automatic control system object and each links' system	Advanced mathematics	0.1	Process assessment + experimental examination + group assessment + final exam	4 years or 1 year	0.78	0.79	0.74
	College Physics	0.2			0.83		
	College Physics Experiment	0.1			0.80		
	Complex function and integral transformation	0.1			0.73		
	Chemical Engineering Foundation	0.2			0.79		
	Weight accumulation	0.7			0.79		
2.2 Be able to analyze the function, structure and system of electronic automation products	Circuit analysis A	0.1	Process assessment + experimental examination + group assessment + final exam + defense	4 years or 1 year	0.80	0.81	
	Analog Electronic Technology	0.1			0.83		
	Digital electronic technology	0.1			0.77		
	Electronic engineering design	0.2			0.83		
	Microcomputer principle and interface technology	0.1			0.80		
	Single chip microcomputer engineering practice	0.1			0.83		
	Embedded system and its application	0.1			0.76		
	Testing technology and instruments	0.1			0.86		
	Instrument technology professional practice	0.1			0.82		
	Weight accumulation	1			0.81		
2.3 Be able to analyze the principles, structures, systems and engineering of automatic control systems	Automatic control principle A	0.4	Process assessment + experimental examination + group assessment + final exam + defense	4 years or 1 year	0.73	0.79	
	Modern control theory	0.4			0.85		
	Integrated design of control system	0.1			0.80		
	Advanced control technology	0.1			0.75		
	Weight accumulation	1			0.79		
2.4 Be capable of literature review and research for automatic products and automatic system engineering	Single chip microcomputer engineering practice	0.2	Process assessment + experimental examination + group assessment + final exam + defense	4 years or 1 year	0.67	0.74	
	The principle and application of DCS/PLC/FCS B	0.1			0.65		
	Science and Technology Writing	0.3			0.71		
	The computer process control engineering B	0.1			0.86		
	Graduation project (Thesis)	0.3			0.80		
	Weight accumulation	1			0.74		

The calculation for graduation requirements achievement is quantitative evaluation for whether the learning output of the teaching activities meets the graduation requirements. The purpose of evaluation is to continuously improve students' teaching activities. Therefore, based on the calculation for graduation requirements achievement, we improve the professional teaching activities on the formulation of the graduation requirements index system, curriculum integration and curriculum teaching reform.

6. Conclusion

The evaluation method for graduation requirements achievement is explored and put into practice. Be applied to graduates, the method can evaluate whether the professional graduates meet the quality standards set by graduation requirements, analyze and find the weak items of which the professional graduates meet the quality standards set by graduation requirements. Accordingly, our major can promote the continuous improvement of teaching activities to ensure that the graduates can achieve the professional graduation requirements. Be applied to curriculum, the method can evaluate the graduation requirements achievement for course teaching, analyze and find the weak items of which the course teaching meet the quality standards set by graduation requirements. Accordingly, our major also can promote the continuous improvement of teaching activities. The method has been applied to Automation engineering professional education certification in our school, which has achieved very good results.

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